DEFENSE THREAT REDUCTION AGENCY

The Defense Threat Reduction Agency (DTRA) is actively involved in meeting current threats to the Nation and working toward reduction of threats of all kinds in the future. To meet these requirements, the Agency is seeking small businesses with strong research and development capability. Expertise in weapons effects (blast, shock and radiation), arms control, and counter-proliferation technologies will be beneficial. Proposals will be accepted only by electronic submission at www.dodsbir.net/submission.

The proposals will be processed and distributed to the appropriate technical offices for evaluation. Questions concerning the administration of the SBIR program and proposal preparation should be directed to:

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Use of e-mail is encouraged for correspondence purposes.

DTRA has identified 10 technical topics numbered DTRA 01-001 through DTRA 01-010. These are the only topics for which proposals will be accepted. The current topics and topic descriptions are included below. The DTRA technical offices, which manage the research and development in these areas initiated these topics. Several of the topics are intentionally broad to ensure any innovative idea fitting within DTRA's mission may be submitted. Proposals do not need to cover all aspects of these broad topics. Questions concerning the topics should be submitted to Mr. Yoho at the above address or to the topic POC identified with the topic.

Potential offerors must submit proposals in accordance with the DoD Solicitation document. Proposal selection will be limited to those, which do not exceed $100,000 and six months of performance. For information purposes, Phase II considerations are limited to proposals of $750,000 and 24 months of performance or less.

DTRA selects proposals for funding based on the technical merit of the proposal, criticality of the research and the evaluation criteria contained in this solicitation document. As funding is limited, DTRA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and filling the most critical requirements. As a result, DTRA may fund more than one proposal under a specific topic or it may fund no proposals in a topic area. Proposals, which cover more than one DTRA topic, must be submitted once - referencing the several areas of applicability.

While funds have not specifically been set aside for bridge funding between Phase I and Phase II successful proposals, the potential offeror is advised to read carefully the conditions set out in this solicitation for FAST TRACK Phase II awards.

In order to enhance Phase II efforts and to assist in assuring acquisition support from the DTRA SBIR program, the Agency may provide a Phase II Awardee with additional Phase II SBIR funding beyond the initial award sum. The additional funding is conditioned on the company matching the additional SBIR funds with DoD acquisition funds or monies provided from external sources. At the discretion of the DTRA requiring activity, additional dollars may be provided by DTRA activities with heavy interest in the areas of endeavor being pursued by the Phase II award recipient under the SBIR contract applying the same matching arrangement. These conditions will be applicable to awards made pursuant to this DoD Solicitation and subsequent solicitations, for a trial period of three years. This is the third of the three-year period.

Notice of award will appear first in the Agency Web site at http://www.dtra.mil. Unsuccessful offerors may receive debriefing upon written request only. E-mail correspondence is considered to be written correspondence for this purpose and is encouraged.

DEFENSE THREAT REDUCTION AGENCY FY 2002.1 TOPIC DESCRIPTIONS

DTRA 02-001 TITLE: Agent Defeat Weapons based on High Temperature Incendiaries

TECHNOLOGY AREA: Chemical/Biological Defense, Materials/Processes, Weapons

BACKGROUND: DTRA is developing weapon concept(s) to defeat enemy biological and chemical facilities without causing significant collateral effects (that is, without releasing live agents into air). DTRA has developed a group of high temperature incendiaries (HTI) that are efficient in killing dry spores when properly mixed. HTIs are shown to react from heat or shock inputs. In nominal weapon-target interaction configurations, both types of HTI reactions were shown to create enough mixing between HTI reaction products and dry spores to kill most of the spores.

REQUIREMENT: All these point to a promising technology. However, for a weapon to be successful, it needs to be effective against a variety of targets in various adverse conditions, without causing undue collateral effects. There are different types of target structures (above-ground, cut-and-cover, or deeply buried), different types of agents (dry spores, vegetative cells, viruses, toxins, chemical agents), different types of containment of agents (plastic, steel, large, small), etc. Then there are uncertainties of target configuration (doors, windows, stand-alone containers, stacked containers, dividing walls), and issues of accuracy of weapon functioning, etc.

DESIRED: New and innovative technologies and approaches to address the above requirement are sought for. These might include new types of energetic materials that can create hostile environment (e.g. more caustic reaction products) to the agents effectively (e.g. effective mixing by tailored blasts or effective heat transfer by slower burning). These might include devising better ways of killing all agents mentioned above. Or, these might include designing effective weapon concepts against a variety of targets. These still might include creative approaches to efficiently validate the weapon concepts against a variety of the above-mentioned parameters.

PHASE I: Identify and execute exploratory investigations for possibilities of development of a new and innovative agent defeat weapon concept or its component.

PHASE II: Build and test prototype agent defeat weapons based on Phase I effort.

PHASE III: A successful proof-of-concept test of an agent defeat weapon be conducted based on earlier efforts. Potential commercialization applications include environmental site remediation.

KEY WORDS: agent defeat, biological agents, chemical agents

DTRA 02-002 TITLE: Reliable Identification of Secondary Seismic Phase Arrivals

TECHNOLOGY AREA: Information Systems

OBJECTIVE: Innovative Techniques for Improved Determination of the Arrival of Secondary Seismic Phases in the Seismic Signature from Explosions.

DESCRIPTION: Since 1992 the U.S. has observed a moratorium on the testing of nuclear devices. However, monitoring for nuclear explosions by other states continues. One component of nuclear explosion monitoring system are networks of seismic sensors. A key parameter produced by processing the data from such networks is the location of a seismic event (including explosions), the hypocenter (latitude, longitude, depth). DTRA is pursuing a number of research topics to improve hypocenter estimates and reduce the parameter uncertainty. A reduction in uncertainties will reduce the geographic area to be examined, thereby increasing the probability that the site of a clandestine test could be located. Furthermore, better definition of the uncertainty ellipse would assist the U.S. in determining the appropriate response, especially where the possible location of the explosion was near political boundaries or land/sea interfaces. This topic addresses the use of secondary seismic phases in determining hypocenter estimates and associated uncertainties.

Secondary seismic phases (such as pP, Sn, and Lg) can enhance the solution of the hypocenter. However, an examination of selected "calibration" events maintained by the Center for Monitoring Research (CMR, DTRA contractor; see web site below) has shown that the selected arrival times and/or phase identification for the secondary phases are inconsistent. Different analysts have picked different arrival times. Therefore, using these arrival times to calculate the hypocenter may increase the uncertainty rather than enhance the accuracy of the location of the hypocenter.

The contractor should propose innovative criteria and an automated process for establishing arrival times of secondary seismic phases and articulate a corresponding theoretical basis.. DTRA is therefore interested in an automated process that will: (1) Reliably identify when such phases come into each station, (2) Assign a meaningful reliability estimate to the determined arrival time, and (3) Relate this reliability to the model reliability and the primary phase arrival time reliability estimate. The desired research may involve multi-component processing and array processing.

PHASE I: Develop overall system design and demonstrate proof-of –concept.

PHASE II: Produce prototype software modules and conduct tests showing validity of approach.

PHASE III DUAL USE APPLICATIONS: Better and more rapid location of explosions, thereby improving the probability of locating the source of the explosion. Also can provide better and more rapid location of earthquakes, thereby allowing better determination of responders, especially near political boundaries. Will also allow rapid determination of future seismic hazards.

REFERENCES: www.cmr.gov
Tibuleac, Ileana and Herrin, E. T., "An Automatic Method for Determination of Lg Arrival Times Using Wavelet Methods", Seismological Research Letters, 70, 577-595.
Zhao, L.-S. and C. Frohlich, "Determination of Near-Station Crustal Structure and the Regional Seismic Event Location Problem", Proc., 17th Annual Seismic Research Symposium, edited by J. F. Lewkowicz, J. M. McPhetres, and D. T. Reiter, 941-950, 1995.
Song, Xi and Helmberger, Donald V., "Pseudo Green's Functions and Waveform Tomography", Bull. Seismol. Soc. Amer., v. 88, No. 1, p. 304-312, 1998.

DTRA 02-003 TITLE: New Sensors to Discriminate Between Nuclear Explosions and Chemical Explosions or Natural Events

TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop innovative sensors whose outputs may be combined with seismic signals to distinguish between nuclear explosions, chemical explosions, or natural events.

DESCRIPTION: Global networks of sensors have been, and are being, deployed to monitor for clandestine nuclear tests. One processing center for data from such a network is being developed at the Center for Monitoring Research (CMR) in Arlington VA. The sensor data streams at CMR include seismic, hydroacoustic, infrasound and radionuclide sensors. A potentially powerful means of identifying the type of source of events ("discrimination"), particularly small events, in the seismic stream is to combine the seismic signals with signals from one or more of the other sensor data streams ("data fusion"). Identification of these small events, however, can still be problematic, with difficulties in distinguishing between small nuclear explosions, chemical explosions, and small earthquakes. Therefore, DTRA has a need for the development of sensors other than the ones currently being used (hydroacoustic, infrasound, and radionuclide) to assist in the identification of source type for small events in the seismic data stream. Innovative approaches, such as sensors detecting changes in the Earth's gravity field or magnetotelluric fields, may be of interest. (This SBIR topic, however, is not restricted to these two approaches – other approaches may also be of interest.) These sensors should be capable of detecting these changes at distances of several thousand kilometers. Space-based sensors, however, will not be considered. The work should include appropriate algorithms to carry out the identification of source type.

PHASE I: Carry out preliminary design of proof-of-concept tests.

PHASE II: Build prototype/acquire sensor(s), conduct tests sufficient to demonstrate proof-of-concept.

PHASE III DUAL USE APPLICATIONS: A successful proof-of-concept test could lead to deployment of a new sensor network to assist in nuclear explosion monitoring. Additionally, sensors based on measurements of the earth's gravity field or electromagnetic field could lead to improved scientific monitoring of the earth. These types of sensors, or sensors based on other principles, could be used to detect and monitor natural events (included those potentially hazardous).

REFERENCES: www.cmr.gov
"A Fifty Year Commemorative History of Long Range Detection, The Creation, Development, and Operation of the United States Atomic Energy Detection System", HQ Air Force Technical Applications Center, Patrick Air Force Base, Florida, September 1997.

KEYWORD LIST: seismic signals, nuclear explosions, chemical explosions, discrimination, fusion, sensors, gravity field, magnetotelluric fields

DTRA 02-004 TITLE: Botanicals as Chemical Warfare Agent Indicators

TECHNOLOGY AREA: Chemical/Biological Defense

OBJECTIVE: Develop a sensing system designed to detect differences between ordinary plants, and those exposed to Chemical Warfare (CW)-related compounds (and their degradation products) in an ambient environment.

DESCRIPTION: The US DoD has a need to protect its personnel, as well as civilians under the protection of US troops, from recently deployed chemical weapons. These materials can be particularly threatening to troops on battlegrounds and terrorist attack zones. No rapid screening or detection methods exist to assure that these areas are free from such hazards. Detection technologies such as these could also greatly benefit

US contributions to the Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on Their Destruction (CWC) under alleged use scenarios.

The Defense Threat Reduction Agency (DTRA) is responsible for providing RDT&E support to protect DoD assets and equities from CW threats. DTRA, therefore, is seeking innovative techniques to detect specific and definitive plant "stress" occurring from exposure to CW-related compounds. DTRA has found that most CW agent detectors are designed to directly detect the agents themselves, rather than employ environmental indicators such as vegetation to identify chemical weapons storage, manufacture, or use. Botanicals' behavior in these circumstances may prove to be an excellent indicator to determine CW-related compound contaminated areas.

This solicitation seeks R&D concerning the CW-related compound effects on botanicals. Proposals may range over a wide purview of subject matter that include:
(1) theoretical analysis coupled with experimental testing of plant effects caused by exposure to toxic chemicals that may be introduced into the environment;
(2) development and/or testing of instruments that can exploit the plant indicators to produce measurable signals and,
(3) signal processing technology to improve the level of detection of the toxified plant with high background signal clutter.

It is well known that some plants exhibit symptoms of stress upon exposure to organophosphorous pesticides that chemically resemble some nerve agents. However, little research has been done to determine botanical reactions to any of the agents themselves. The mechanism(s) by which CW molecules affect plants appears poorly understood. Perceptible and exploitable effects may include variations in: (1) spectroscopic patterns from leaves; (2) plant structural growth or behavior; (3) variation in volatile plant chemicals produced; (4) soil chemistry; and (5) plant species, in addition to other variables or properties not elaborated.

Chemical agent possession is tightly controlled in the US. Access to these materials is neither required, nor desirable for proposals to this solicitation, as most plants would only be exposed to dilute solutions of CW primary degradation compounds. (e.g., phosphonic acids from nerve agents or thiodiglycol for mustard).

PHASE I: Demonstrate proof of concept of using vegetation as indicators of CW-related molecule exposure in the environment. Document the testing procedures, the measured environmental influences on the plants, statistically-significant testing, raw test data, test statistical results and provide premises, caveats, test result interpretations, findings and recommendations in a Final Report.

PHASE II: Develop concept demonstrated in Phase I that exploits measurable plant effect(s) to detect chemical agents using vegetation for on-site screening. Develop an analytical procedure/ instrument prototype and determine its utility in sensing CW-related molecules. Conduct tests to obtain performance features and limitations. Field testing may be performed at a facility to be determined by DTRA. Submit final prototype design, testing procedures, test results, findings and recommendations in a Final Report.

PHASE III: Develop the product of Phase II to provide a practical technology that will be attractive for military or homeland defense applications. Conduct testing and evaluation to extend its utility to detect pesticides and other environmental residues or contamination, narcotic processing chemicals and unusual flora. Commercialization potential includes environmental protection applications for monitoring exposure to pesticides, herbicides, etc.

REFERENCES:

1. Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction, 13 January 1993. (http://www.opcw.nl/cwc/cwc-eng.htm)

KEYWORD LIST: Sensor, Chemical Weapons, CWC, Fluorescence, Indicators, On-Site Analysis.

DTRA 02-005 TITLE: Sub-Lethal Chemical Weapons Exposure Detection in Humans

TECHNOLOGY AREA: Chemical/Biological Defense, Biomedical

TECHNOLOGY AREAS: TWO PRIMARY AREAS: 1)Chemical/Biological Defense, and 2) Biomedical

OBJECTIVE: To develop non-serum based chemical detection systems to test for human exposure to chemical agents. Results from this project will benefit forensic studies for chemical & biological defense, homeland defense, law enforcement, environmental testing, and will also promote the advancement of non-invasive testing in the medical diagnostic community.

DESCRIPTION: When warfighters return from an unknown enemy area where chemical weapons were potentially used, manufactured, or stored, it is difficult to confirm if soldiers were exposed to sublethal levels of chemical weapons. Current solutions center around advance site monitoring before soldiers enter, but these technologies may not be able to adequately detect sub-lethal CW levels in the air, water, or on surfaces. Furthermore, current technologies track potential exposure rates on a per-incident basis, and do not track cumulative exposures of each soldier over time. For these measurements, the military relies upon blood and urine screening of each individual soldier. These samples must be collected sometimes under field conditions and samples must be taken frequently. However, the samples only represent a "snapshot" measurement. In a battlefield environment, the logistics of this monitoring effort are burdensome, impractical to execute, and may lead to incorrect results if samples are not stored and analyzed within specified holding times. Low-level CW detection in humans is even more difficult when non-DoD personnel must be tested (such as in a terrorist or military attacks), as blood sampling is invasive and the most common procedures for on-site testing require baseline blood tests that cannot be obtained post-attack. Therefore, a need exists for less invasive, low-level CW exposure testing that requires no individual background sampling of blood or urine.

The Defense Threat Reduction Agency (DTRA) provides R&D support to protect DoD assets and equities from WMD threats. DTRA, therefore, is seeking innovative technologies to detect low-level CW exposure in humans. Preferred techniques should not require blood sampling or testing which requires background study on each patient. DTRA has reviewed other CW R&D efforts sponsored by the US Government (USG), and has determined that other CW detection efforts in humans focus either on acute exposure, are too invasive to be practical in a battlefield situation, or are too labor intensive to conduct on a quick-turnaround or high throughput basis.

This solicitation seeks R&D efforts to detect CW agents, their degradation and precursor compounds, and simulant chemicals that model the behavior of the various CW compounds (hereafter called target compounds). Due to restrictions on the use and handling of CW compounds, research should focus on non-agent compounds exclusively for this Phase I request for proposal. Animal testing in vivo is not required to qualify for Phase I awards, however the research test matrix must resemble a human matrix. Acceptable sampling matrices include hair, nails, skin, skin scrapings, or glandular excretions, but may not include blood, urine, internal tissue organs, or any other sample matrix that is invasively sampled. Proposals may address a variety of topics that include:

(1) theoretical analysis coupled with experimental testing of long-term CW-related compound exposed samples;
(2) research and development of instruments or methods that can detect CW-related compounds obtained non-invasively from human matrices;
(3) detection of target compounds where they are absorbed by the body after an attack, or excreted by the body such as hair, nails, skin, etc . (other than urine and feces);
(4) extraction techniques to facilitate on-site and rapid detection of the desired matrix.

Techniques that employ on-site testing or sample extraction techniques are highly desirable. Detection techniques may, but are not required to detect the target compounds themselves. Proposals may also address the detection of changes in human physiology that result from CW exposure.

PHASE I: Demonstrate proof of concept using sample matrices to detect sub-lethal levels of target compounds; document the sampling requirements and testing protocols, results, and conclusions resulting from the study, and provide recommendations for continuing research.

PHASE II: Develop concept demonstrated in Phase I for actual on-site application; develop testing procedure to detect chemical agent; demonstrate prototype's utility in sensing CW in non-invasively obtained human matrices; refine sampling and analysis methodology; conduct prototype development; provide analytical data.

PHASE III: Reduce the technique developed under Phase II to high volume assays; improve prototype instrument design to reduce cost and provide a system that will be attractive to use in multiple areas of military or homeland defense projects; perform extensive testing of the prototype to develop a marketable product. Commercialization potential includes pharmaceutical industry and environmental protection applications for monitoring exposure to pesticides, herbicides, etc.

REFERENCES:
1. Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on their Destruction, 13 January 1993.

KEYWORD LIST: Sensor, Chemical Weapons, detection, on-site, sampling, analysis, method development, hair, skin, CWC

DTRA 02-006 TITLE: <u>Particulate Mass Flow</u>

TECHNOLOGY AREA: Materials/Processes , Sensors, Electronics, Battlespace

OBJECTIVE: Develop an instrument that can measure mass flow rates in the products produced by the detonation and or deflagration of an energetic material.

DESCRIPTION: DTRA is currently testing the effects of energetic materials on structures or the contents of structures. Amongst the effects are the loads produced by the fireball that result from the detonation or deflagration. This fireball can contain particulate matter that varies in composition. The object of this effect will be to do the research necessary to produce/innovate a gage or measurement technique that can determine the mass flow rate of this particulate matter in the gases within the fireball. The gage will have to work in thermal environments that can range up to 3000 C. The mass density of the particle can vary widely. It could be, as examples, metal oxides or free carbon. The object is to measure the rate at which particulate mass passes through a given area or the particulate mass flux. The respondent in his proposal should estimate the accuracy and achievable frequency response of the measurement. The frequency response may vary as a function of the particulate size and mass flux.

During Phase I, build a prototype of the gage or system of transducers and demonstrate with laboratory tests and/or small scale field tests that one can infer the particulate mass flux.

During Phase II, build and field a number of the instruments on tests to be specified by DTRA.

PHASE III COMMERCIALIZATION: In addition to the Department Of Defense (DOD) applications, the technology developed will be useful in cloud analysis, smoke stack emissions, and internal combustion engine emissions.

KEYWORD LIST: Stress, Normal Stress, Hard Rock, Conventional Weapons Effects, Nuclear Weapons Effects, Stress Wave Propagation.

DTRA 02-007 TITLE: The Measurement of Stress in Hard Rock

TECHNOLOGY AREA: Materials/Processes, Sensors, Electronics, Battlespace

OBJECTIVE: Develop an instrument that can reliably measure normal stress in hard rock and help study stress wave propagation in Rock.

DESCRIPTION: DTRA conducts conventional weapons effects tests and simulated nuclear weapons effects tests using high explosives. Often these tests are conducted in hard rock (such as granite) test beds. The measurements done are usually those from which particle velocity can be inferred. It would also be advantageous to measure normal stress. It should be noted that these test beds can be large. The gages may be place in boreholes that can be of the order of 100 meters long. The basic requirement is to obtain data that can be used to infer the normal stress-time history of the stress wave in the rock. The respondent should be able to demonstrate in the laboratory that the proposed technique is a measurement of normal stress. The technique does not necessarily have to be a direct measure of the normal stress time history, it is only required that the normal stress-time history can be inferred from the measurement. Ease of placement of the gage in boreholes will be one of the criteria used to judge the candidate proposals.

During Phase I, build prototypes of the gage and demonstrate with laboratory tests and/or small scale field tests that one can infer both peak stress and stress-time history using the instrument.

During Phase II, build and field a number of the instruments on tests to be specified by DTRA.

PHASE III COMMERCIALIZATION: In addition to the Department Of Defense (DOD) applications, the technology developed will be useful in mine safety applications, shale oil extraction and earthquake prediction and analysis.

KEYWORD LIST: Stress, Normal Stress, Hard Rock, Conventional Weapons Effects, Nuclear Weapons Effects, Stress Wave Propagation.

DTRA 02-008 TITLE: Fuel Cells for Arms Control Applications

TECHNOLOGY AREA: Materials/Processes, Sensors

OBJECTIVE: DTRA requires a man-portable fuel cell capable of producing 220 watts of continuous direct current (DC) electrical power for a nominal 12 hours without refueling. The weight of the fuel cell must be such that a person of average strength could carry the unit for a short distance. The fuel cell must be easily refuelable in the field by non technical personnel (e.g., through "clip-in/drop-in" ampoules of fuel) in a way that would not pose a hazardous material risk prior to use, during use in the fuel cell, or following use. The fuel cell, less fuel, must be rugged and transportable as checked baggage on commercial airlines. Furthermore, it must be effective in a wide range of temperatures and other variable environmental conditions.

DESCRIPTION: Technologies capable of verifying future arms control agreements will require self-contained and man-portable power modules for operation in remote locations. Whether the fundamental activity is a part of a portable instrument or an unattended system, long-term power provision in a lightweight, self-contained package is necessary. Power modules may be used to intermittently power computer equipment, video monitoring equipment, or environmental sensors, but the highest power consumption is undoubtedly from thermal cycling applications. Many measurement systems have been demonstrated whose performances are power-limited in remote or rugged applications. Standard power sources are either inordinately heavy/immobile (generators), contribute to operational hazards, or store insufficient energy for the desired applications (e.g., batteries). During on-site inspection activities, the logistics of providing power rapidly becomes the limiting operational factor.

A lightweight high-performance long lasting power module is advantageous because it lowers the support burden, either reducing the number of resupply trips necessary or the amount of equipment needed to transport to an inspection. Currently available fuel cells are bulky, inefficient, and unable to produce the sustained energy required. In both storage and operation, a longer working lifetime is desirable.

The developed fuel cell should employ an innovative approach combining size and power storage capacity with output control modules to maximize the utility and application of the fuel cell. A preference will be given to adaptive learning or control algorithms over hard-wired selective outputs.

PHASE I: Develop a system design based on providing 220 watts of continuous DC electrical power for 12 hours. Demonstrate that the weight of the power module will be such that a person of average strength could carry the unit for a short distance.

PHASE II: Develop and demonstrate a prototype system with a weight, ruggedness, and environmental resistance sufficient to field the fuel cell under harsh conditions. The fuel cell must be easily refuelable in the field by non technical personnel (e.g., through “clip-in/drop-in” ampoules of fuel) in a way that would not pose a hazardous material risk prior to use, during use in the fuel cell, or following use. The fuel cell, less fuel, must be rugged and transportable as checked baggage on commercial airlines. Furthermore, it must be effective in a wide range of temperatures and other variable environmental conditions. Conduct testing to prove feasibility over extended operating conditions.

PHASE III: DUAL USE APPLICATIONS: A portable fuel cell has a wide variety of military and commercial applications in surveillance and security. Examples are remote and perimeter monitoring, securing industrial facilities, and providing power at emergency locations.

KEYWORD LIST: Arms control verification, arms control compliance, fuel cells and batteries, portable power sources, unattended monitoring.

DTRA 02-009 TITLE: <u>Nuclear Weapon Surety Risk Management</u>

TECHNOLOGY AREA: Materials/Processes, Weapons, Nuclear Technology

OBJECTIVE: Improved Surety of US Nuclear Weapons Systems

DESCRIPTION: Quantifying, reducing, and managing the risks associated with the life-cycle management of military weapon systems, including demilitarization activities, is of vital importance to ensure the safety, security, and control of our nation's nuclear weapons stockpile. To this end, several nuclear weapon system safety assessments and special studies have been or are currently being conducted by the Defense Threat Reduction Agency (DTRA). These use probabilistic risk assessment techniques primarily to quantitatively estimate the likelihood of plutonium release from weapons associated with various delivery platforms resulting from accident-induced abnormal environments. Abnormal environments may include mechanical insults (e.g. drops, vehicle accidents), thermal insults (e.g. fuel fires), electrical insults (e.g. lightning), and combinations of these environments. These risks are estimated to be quite small, but the assessments allow component commanders to better balance the prevention and mitigation of accidents against the potential cost of consequence management and operational requirements by focusing limited resources in those areas which have the greatest potential to continue improving overall stockpile surety. Long-range program thrusts include characterizing these abnormal environments, through test and modeling/simulation, analyzing human factors that can be a significant source of hazards, and developing and integrating quick running codes/models to allow decision makers to manage surety risks. Innovative concepts to improve and extend these techniques and methodologies are desired to continue improving the safety, security and control of the Nation's nuclear weapons stockpile, as well as applying these techniques to other areas of interest to the Department of Defense. DTRA is particularly interested in the following areas of study, which can be evaluated individually of grouped together: 1) analysis and prevention of environments leading to inadvertent nuclear detonation (IND), 2) prediction of consequences from plutonium dispersal and IND in terms of litigation and site restoration, 3) determine a combinatorial optimization of logistics movements to reduce plutonium dispersal risk, and 4) determine the global probability of a terrorist attack on a facility on any given day that can be combined with other probabilities for success or failure given the attack.

PHASE I: Demonstrate the feasibility and potential usefulness of the proposed technology or technique.

PHASE II: Fully develop the proposed technology or technique so they can be compared to existing techniques.

PHASE III DUAL USE APPLICATIONS: Hazard/risk analysis tools and techniques have wide applicability. They are currently used in a variety of high-risk/high-consequence activities, such as space shuttle operations, chemical plant operations, nuclear power operations, ocean engineering, and hazardous waste cleanup. As risk analysis tools and techniques become more prevalent, these techniques may be more quickly and efficiently applied to a greater variety of applications where safety and security risks must be managed. Military organizations may apply these tools through detailed assessments in concert with operational risk management principles; these support operational decisions as well as planning functions. Other federal, state, and local governments may require the use of these tools as the threats of terrorism on U.S. soil increases and the potential for nuclear-related industries who have lost experienced personnel see the demand increase in the near future.

KEYWORDS: Surety, Safety, Security, Use Control, Risk, Nuclear Weapons, Abnormal Environments, Mechanical Hazard, Thermal Hazard, Electrical Hazard, Human Factors, Risk Reduction, Accident Initiators, Probabilistic Risk Analysis, Risk Mitigation, Risk Management, Consequence Management, Accident Prevention, Optimization, Terrorist.

DTRA 02-010 TITLE: X-Ray Simulators and Other Pulsed Power Applications

TECHNOLOGY AREA: Sensors, Electronics

OBJECTIVE: Develop innovative technologies for the efficient production of x-rays for nuclear weapons effects testing and for the application of compact pulsed power to military and civilian systems.

DESCRIPTION: X-ray nuclear weapon effects testing uses radiation sources that generate primarily cold x-rays (1-15 keV), warm x-rays (5-60 keV), or hot x-rays (>30 keV). Soft x-rays are used for optical and optical coatings effects testing; warm x-rays are used for thermomechanical and thermostructural response testing; and hot x-rays are used for electronics effects testing. Future requirements for x-ray nuclear weapon effects testing will require substantial improvements in existing radiation source capability, to increase yield and power by 1-3 orders of magnitude, improve spectral fidelity, and increase predictability and experimental control. These improvements may require new concepts in source design, power generation, pulse compression, experimental and measurement techniques, data analysis and modeling, and methods to reduce facility system and operation costs. The proposer should be familiar with the present capability to produce x-rays for nuclear effects testing.

Plasma Radiation Source (PRS) devices are typically gas puffs or wire arrays that are imploded by conduction of large currents to generate soft x-rays. Present PRS designs for high-power DTRA simulators are limited by Rayleigh-Taylor and MHD instability growth, thus innovative load designs may allow for more efficient production of x-rays to meet the goals of increasing fluences by 100-200%. An important contribution could come from physics-based modeling of this complex system, particularly with the high-performance parallel computers now available.

PRS devices generate copious amounts of extraneous debris (material, atomic charged particles, sub-keV photons), from which test objects must be shielded. Debris shields must minimize particle flux and maximize exposure area without significantly reducing x-ray fluence. New, innovative methods, or a combination of methods, may be needed to stop, mitigate, and/or delay debris generated for radiation simulators.

The latest generation of DTRA high-power generators has a relatively large pulse length (~300 ns) which is problematic for both plasma radiation sources and brehmsstrahlung sources. Novel pulse compression technology, including plasma opening switches (POS), flux compression, and even current multiplication could be important for obtaining maximum performance from these x-ray sources. Better computer modeling is needed, especially to understand the opening process in POS and its relationship to conduction dynamics, as well as the dynamics of flux compression.

Bremsstrahlung Radiation Source (BRS) devices generate hot x-rays by impinging an electron beam onto a target converter. Innovative BRS converter and/or beam transport designs are needed to meet future test requirements, by increasing x-ray production (dose) by as much as 3 orders of magnitude, better tailoring pulse width (increased dose rate by as much as 1 order of magnitude), and improving spectral fidelity. These improvements could be effected by innovative new BRS designs, or by better understanding and refinement of existing BRS designs. Comprehensive computer modeling (e.g., PIC codes) of cathode formation and electron emission, beam transport, and/or converter physics, could provide an important contribution.

Diagnostics are critical for understanding how radiation simulators (cold, warm, or hot) are operating and how their performance can be improved. For example, in a PRS machine, these diagnostics are needed during all of the phases of implosion: current build-up, run-in, pinch, and bounce. Innovative diagnostics that can determine with good accuracy the electron density, neutral density, electron temperature, ion temperature, neutral temperature, radiation spectrum, and magnetic field structure, both spatially and temporally resolved, would be a boon to the overall radiation simulator program. In addition, absolutely calibrated x-ray power measurements in different energy spectrums are necessary. Innovative diagnostics are needed to accurately determine the fluence and spectrum of x-rays produced in both cold and hot x-ray simulations.

Future requirements for systems employing pulsed power will necessitate improvements in efficiency, energy density, reliability, repeatability and overall performance over the existing state of the art. Innovative approaches for component or subsystem development are sought to meet future demands for radiation simulators and other pulsed power applications. Examples include more energy efficient pulse forming technologies, high energy density capacitors, more efficient insulators, improved and more reliable switching technologies, and improved power flow electrical circuit models. Pulsed power technologies include those that operate at kilovolts to megavolts and kiloamperes to megamperes, support repetition rates from single pulse to 10 kilohertz, and provide individual pulse risetimes in the nanosecond to millisecond range.

Current DoD pulsed power applications includes x-ray simulators, armor/anti-armor; electromagnetic/electrothermal guns; mine-countermine; electrical vehicle stoppers, and directed energy weapons; etc. Development of new and innovative applications requiring advanced pulsed power technology is also desired, especially applications that may expand a primarily DoD driven requirements base into the commercial sector and reduce component and system costs.

PHASE I: Demonstrate the feasibility of the proposed concept.

PHASE II: Develop, test and evaluate proof-of-principle hardware. In the event the contractor proposes to demonstrate the prototype in an above ground test simulator, DTRA will coordinate the demonstration at its facility.

PHASE III DUAL USE APPLICATIONS: In addition to the applications cited for developing the environments for simulating the effects of nuclear weapons, the technologies could be useful with the commercial operations of advanced computer modeling of plasmas, nuclear instrumentation, very fast closing valves, material surface treatments, environmental clean-up and high brightness x-ray sources. In addition to the DoD applications cited, these pulse power component technologies will be useful in cleaning up smokestack effluents, general environmental pollution control, metal cutting, and electric vehicles.

REFERENCES:
(1) Inductive Energy Technology for Pulsed Intense X-Ray Sources, K. D. Ware, P. G. Filios, R. L. Gullickson, J. E. Rowley. R. F. Schneider, W. J. Summa, I. M. Vitkovitsky, IEEE Transactions on Plasma Science, Vol. 25, No. 2, April 1997.
(2) Glasstone and Dolan, The Effects of Nuclear Weapons, 1977
(3) DNA EM-1, Capabilities of Nuclear Weapons
(4) Radiation Test Facilities and Capabilities, 1997, DASIAC, 2560 Huntington Ave., Alexandria, VA 22303 (also on web site: http://www.dswa.mil/dswainfo/es/hp.htm)
(5) J. C. Martin on Pulsed Power, Edited by T. H. Martin, A. H. Guenther, and M. Kristiansen, Plenum Press,
New York and London, 1996, ISBN 0-306-45302-9.

KEYWORD LIST: Advanced Simulator, Above Ground Test (AGT), X-Ray, Debris, Pulsed Power, Radiation, Simulation, Modeling, Test, Electronics, Optics, Nuclear Weapon Effects, Electromagnetic, Electrothermal, Hybrid Electric Guns, High Coulomb Switches, Crowbar Diodes, High Energy Capacitors, Static Electrical Storage Devices.

Topic#: DTRA02.1-001
Command: DTRA

Title: Agent Defeat Weapons based on High Temperature Incendiaries

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Tech Area:
_ Air Platform X Chemical/Biological Defense _ Information Systems
_ Ground/Sea Vehicles X Materials/Processes _ Biomedical
_ Sensors _ Electronics _ Battlespace
_ Space Platforms _ Human Systems X Weapons
_ Nuclear Technology

Description

Background:
DTRA is developing weapon concept(s) to defeat enemy biological and chemical facilities without causing significant collateral effects (that is, without releasing live agents into air). DTRA has developed a group of high temperature incendiaries (HTI) that are efficient in killing dry spores when properly mixed. HTIs are shown to react from heat or shock inputs. In nominal weapon-target interaction configurations, both types of HTI reactions were shown to create enough mixing between HTI reaction products and dry spores to kill most of the spores.

Requirement:
All these point to a promising technology. However, for a weapon to be successful, it needs to be effective against a variety of targets in various adverse conditions, without causing undue collateral effects. There are different types of target structures (above-ground, cut-and-cover, or deeply buried), different types of agents (dry spores, vegetative cells, viruses, toxins, chemical agents), different types of containment of agents (plastic, steel, large, small), etc. Then there are uncertainties of target configuration (doors, windows, stand-alone containers, stacked containers, dividing walls), and issues of accuracy of weapon functioning, etc.

Desired:
New and innovative technologies and approaches to address the above requirement are sought for. These might include new types of energetic materials that can create hostile environment (e.g. more caustic

reaction products) to the agents effectively (e.g. effective mixing by tailored blasts or effective heat transfer by slower burning). These might include devising better ways of killing all agents mentioned above. Or, these might include designing effective weapon concepts against a variety of targets. These still might include creative approaches to efficiently validate the weapon concepts against a variety of the above-mentioned parameters.

Phase I:
Identify and execute exploratory investigations for possibilities of development of a new and innovative agent defeat weapon concept or its component.

Phase II:
Build and test prototype agent defeat weapons based on Phase I effort.

Phase III:
A successful proof-of-concept test of an agent defeat weapon be conducted based on earlier efforts. Potential commercialization applications include environmental site remediation.

Key words: agent defeat, biological agents, chemical agents

DTRA02.1-002
Agency: DTRA
Topic#: DTRA02.1-002
Command: DTRA
Title: Reliable Identification of Secondary Seismic Phase Arrivals

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Tech Area:
_ Air Platform _ Chemical/Biological Defense X Information Systems
_ Ground/Sea Vehicles _ Materials/Processes _ Biomedical
_ Sensors _ Electronics _ Battlespace
_ Space Platforms _ Human Systems _ Weapons
_ Nuclear Technology

TECHNICAL POINT(S) OF CONTACT: Dr. Anton Dainty
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Fax: 703-325-7560

OBJECTIVE: Innovative Techniques for Improved Determination of the Arrival of Secondary Seismic Phases in the Seismic Signature from Explosions.

DESCRIPTION: Since 1992 the U.S. has observed a moratorium on the testing of nuclear devices. However, monitoring for nuclear explosions by other states continues. One component of nuclear explosion monitoring system are networks of seismic sensors. A key parameter produced by processing the data from such networks is the location of a seismic event (including explosions), the hypocenter (latitude, longitude, depth). DTRA is pursuing a number of research topics to improve hypocenter estimates and reduce the parameter uncertainty. A reduction in uncertainties will reduce the geographic area to be examined, thereby increasing the probability that the site of a clandestine test could be located. Furthermore, better definition of the uncertainty ellipse would assist the U.S. in determining the appropriate response, especially where the possible location of the explosion was near political boundaries or land/sea interfaces. This topic addresses the use of secondary seismic phases in determining hypocenter estimates and associated uncertainties.

Secondary seismic phases (such as pP, Sn, and Lg) can enhance the solution of the hypocenter. However, an examination of selected “calibration” events maintained by the Center for Monitoring Research (CMR, DTRA contractor; see web site below) has shown that the selected arrival times and/or phase identification for the secondary phases are inconsistent. Different analysts have picked different arrival times. Therefore, using these arrival times to calculate the hypocenter may increase the uncertainty rather than enhance the accuracy of the location of the hypocenter.

The contractor should propose innovative criteria and an automated process for establishing arrival times of secondary seismic phases and articulate a corresponding theoretical basis.. DTRA is therefore interested in an automated process that will: (1) Reliably identify when such phases come into each station, (2) Assign a meaningful reliability estimate to the determined arrival time, and (3) Relate this reliability to the model reliability and the primary phase arrival time reliability estimate. The desired research may involve multi-component processing and array processing.

PHASE I: Develop overall system design and demonstrate proof-of –concept.

PHASE II: Produce prototype software modules and conduct tests showing validity of approach.

PHASE III DUAL USE APPLICATIONS: Better and more rapid location of explosions, thereby improving the probability of locating the source of the explosion. Also can provide better and more rapid location of earthquakes, thereby allowing better determination of responders, especially near political boundaries. Will also allow rapid determination of future seismic hazards.

REFERENCES: www.cmr.gov

Tibuleac, Ileana and Herrin, E. T., “An Automatic Method for Determination of Lg Arrival Times Using Wavelet Methods”, Seismological Research Letters, 70, 577-595.

Zhao, L.-S. and C. Frohlich, “Determination of Near-Station Crustal Structure and the Regional Seismic Event Location Problem”, Proc., 17th Annual Seismic Research Symposium, edited by J. F. Lewkowicz, J. M. McPhetres, and D. T. Reiter, 941-950, 1995.

Song, Xi and Helmberger, Donald V., “Pseudo Green’s Functions and Waveform Tomography”, Bull. Seismol. Soc. Amer., v. 88, No. 1, p. 304-312, 1998.

DTRA02.1-003
Agency: DTRA
Topic#: DTRA02.1-003
Command: DTRA

Title: New Sensors to Discriminate Between Nuclear Explosions and Chemical Explosions or Natural Events

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Tech Area:
_ Air Platform _ Chemical/Biological Defense _ Information Systems
_ Ground/Sea Vehicles _ Materials/Processes _ Biomedical
X Sensors _ Electronics _ Battlespace
_ Space Platforms _ Human Systems _ Weapons
_ Nuclear Technology

OBJECTIVE: Develop innovative sensors whose outputs may be combined with seismic signals to distinguish between nuclear explosions, chemical explosions, or natural events.

DESCRIPTION: Global networks of sensors have been, and are being, deployed to monitor for clandestine nuclear tests. One processing center for data from such a network is being developed at the Center for Monitoring Research (CMR) in Arlington VA. The sensor data streams at CMR include seismic, hydroacoustic, infrasound and radionuclide sensors. A potentially powerful means of identifying the type of source of events ("discrimination"), particularly small events, in the seismic stream is to combine the seismic signals with signals from one or more of the other sensor data streams ("data fusion"). Identification of these small events, however, can still be problematic, with difficulties in distinguishing between small nuclear explosions, chemical explosions, and small earthquakes. Therefore, DTRA has a need for the development of sensors other than the ones currently being used (hydroacoustic, infrasound, and radionuclide) to assist in the identification of source type for small events in the seismic data stream. Innovative approaches, such as sensors detecting changes in the Earth's gravity field or magnetotelluric fields, may be of interest. (This SBIR topic, however, is not restricted to these two approaches – other approaches may also be of interest.) These sensors should be capable of detecting these changes at distances of several thousand kilometers. Space-based sensors, however, will not be considered. The work should include appropriate algorithms to carry out the identification of source type.

PHASE I: Carry out preliminary design of proof-of-concept tests.

PHASE II: Build prototype/acquire sensor(s), conduct tests sufficient to demonstrate proof-of-concept.

PHASE III DUAL USE APPLICATIONS: A successful proof-of-concept test could lead to deployment of a new sensor network to assist in nuclear explosion monitoring. Additionally, sensors based on measurements of the earth's gravity field or electromagnetic field could lead to improved scientific monitoring of the earth. These types of sensors, or sensors based on other principles, could be used to detect and monitor natural events (included those potentially hazardous).

REFERENCES: www.cmr.gov

"A Fifty Year Commemorative History of Long Range Detection, The Creation, Development, and Operation of the United States Atomic Energy Detection System", HQ Air Force Technical Applications Center, Patrick Air Force Base, Florida, September 1997.

KEYWORD LIST: seismic signals, nuclear explosions, chemical explosions, discrimination, fusion, sensors, gravity field, magnetotelluric fields

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DTRA02.1-004
Agency: DTRA
Topic#: DTRA02.1-004
Command: DTRA
Title: Botanicals as Chemical Warfare Agent Indicators

Tech Area:
_ Air Platform X Chemical/Biological Defense _ Information Systems
_ Ground/Sea Vehicles X Materials/Processes _ Biomedical
X Sensors _ Electronics _ Battlespace
_ Space Platforms _ Human Systems _ Weapons
_ Nuclear Technology

OBJECTIVE: Develop a sensing system designed to detect differences between ordinary plants, and those exposed to Chemical Warfare (CW)-related compounds (and their degradation products) in an ambient environment.

DESCRIPTION: The US DoD has a need to protect its personnel, as well as civilians under the protection of US troops, from recently deployed chemical weapons. These materials can be particularly threatening to troops on battlegrounds and terrorist attack zones. No rapid screening or detection methods exist to assure that these areas are free from such hazards. Detection technologies such as these could also greatly benefit US contributions to the Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on Their Destruction (CWC) under alleged use scenarios.

The Defense Threat Reduction Agency (DTRA) is responsible for providing RDT&E support to protect DoD assets and equities from CW threats. DTRA, therefore, is seeking innovative techniques to detect specific and definitive plant “stress” occurring from exposure to CW-related compounds. DTRA has found that most CW agent detectors are designed to directly detect the agents themselves, rather than employ environmental indicators such as vegetation to identify chemical weapons storage, manufacture, or use. Botanicals’ behavior in these circumstances may prove to be an excellent indicator to determine CW-related compound contaminated areas.

This solicitation seeks R&D concerning the CW-related compound effects on botanicals. Proposals may range over a wide purview of subject matter that include:
(1) theoretical analysis coupled with experimental testing of plant effects caused by exposure to toxic chemicals that may be introduced into the environment;
(2) development and/or testing of instruments that can exploit the plant indicators to produce measurable signals and,
(3) signal processing technology to improve the level of detection of the toxified plant with high background signal clutter.

It is well known that some plants exhibit symptoms of stress upon exposure to organophosphorous pesticides that chemically resemble some nerve agents. However, little research has been done to determine botanical reactions to any of the agents themselves. The mechanism(s) by which CW molecules affect plants appears poorly understood. Perceptible and exploitable effects may include variations in: (1) spectroscopic patterns from leaves; (2) plant structural growth or behavior; (3) variation in volatile plant chemicals produced; (4) soil chemistry; and (5) plant species, in addition to other variables or properties not elaborated.

Chemical agent possession is tightly controlled in the US. Access to these materials is neither required, nor desirable for proposals to this solicitation, as most plants would only be exposed to dilute solutions of CW primary degradation compounds. (e.g., phosphonic acids from nerve agents or thiodiglycol for mustard).

PHASE I: Demonstrate proof of concept of using vegetation as indicators of CW-related molecule exposure in the environment. Document the testing procedures, the measured environmental influences on the plants, statistically-significant testing, raw test data, test statistical results and provide premises, caveats, test result interpretations, findings and recommendations in a Final Report.

PHASE II: Develop concept demonstrated in Phase I that exploits measurable plant effect(s) to detect chemical agents using vegetation for on-site screening. Develop an analytical procedure/ instrument prototype and determine its utility in sensing CW-related molecules. Conduct tests to obtain performance features and limitations. Field testing may be performed at a facility to be determined by DTRA. Submit final prototype design, testing procedures, test results, findings and recommendations in a Final Report.

PHASE III: Develop the product of Phase II to provide a practical technology that will be attractive for military or homeland defense applications. Conduct testing and evaluation to extend its utility to detect pesticides and other environmental residues or contamination, narcotic processing chemicals and unusual flora. Commercialization potential includes environmental protection applications for monitoring exposure to pesticides, herbicides, etc.

REFERENCES:

1. Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction, 13 January 1993. (http://www.opcw.nl/cwc/cwc-eng.htm)

KEYWORD LIST: Sensor, Chemical Weapons, CWC, Fluorescence, Indicators, On-Site Analysis.

DTRA02.1-005
Agency: DTRA
Topic#: DTRA02.1-005
Command: DTRA

Title: Sub-Lethal Chemical Weapons Exposure Detection in Humans

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Tech Area:
_ Air Platform X Chemical/Biological Defense _ Information Systems
_ Ground/Sea Vehicles _ Materials/Processes X Biomedical
_ Sensors _ Electronics _ Battlespace
_ Space Platforms _ Human Systems _ Weapons
_ Nuclear Technology

TECHNOLOGY AREAS: TWO PRIMARY AREAS: 1)Chemical/Biological Defense, and 2) Biomedical

OBJECTIVE: To develop non-serum based chemical detection systems to test for human exposure to chemical agents. Results from this project will benefit forensic studies for chemical & biological defense, homeland defense, law enforcement, environmental testing, and will also promote the advancement of non-invasive testing in the medical diagnostic community.

DESCRIPTION: When warfighters return from an unknown enemy area where chemical weapons were potentially used, manufactured, or stored, it is difficult to confirm if soldiers were exposed to sublethal levels of chemical weapons. Current solutions center around advance site monitoring before soldiers enter, but these technologies may not be able to adequately detect sub-lethal CW levels in the air, water, or on surfaces. Furthermore, current technologies track potential exposure rates on a per-incident basis, and do not track cumulative exposures of each soldier over time. For these measurements, the military relies upon blood and urine screening of each individual soldier. These samples must be collected sometimes under field conditions and samples must be taken frequently. However, the samples only represent a "snapshot" measurement. In a battlefield environment, the logistics of this monitoring effort are burdensome, impractical to execute, and may lead to incorrect results if samples are not stored and analyzed within specified holding times. Low-level CW detection in humans is even more difficult when non-DoD personnel must be tested (such as in a terrorist or military attacks), as blood sampling is invasive and the most common procedures for on-site testing require baseline blood tests that cannot be obtained post-attack. Therefore, a need exists for less invasive, low-level CW exposure testing that requires no individual background sampling of blood or urine.

The Defense Threat Reduction Agency (DTRA) provides R&D support to protect DoD assets and equities from WMD threats. DTRA, therefore, is seeking innovative technologies to detect low-level CW exposure in humans. Preferred techniques should not require blood sampling or testing which requires background study on each patient. DTRA has reviewed other CW R&D efforts sponsored by the US Government (USG), and has determined that other CW detection efforts in humans focus either on acute exposure, are too invasive to be practical in a battlefield situation, or are too labor intensive to conduct on a quick-turnaround or high throughput basis.

This solicitation seeks R&D efforts to detect CW agents, their degradation and precursor compounds, and simulant chemicals that model the behavior of the various CW compounds (hereafter called target compounds). Due to restrictions on the use and handling of CW compounds, research should focus on non-agent compounds exclusively for this Phase I request for proposal. Animal testing in vivo is not required to qualify for Phase I awards, however the research test matrix must resemble a human matrix. Acceptable sampling matrices include hair, nails, skin, skin scrapings, or glandular excretions, but may not include blood, urine, internal tissue organs, or any other sample matrix that is invasively sampled. Proposals may address a variety of topics that include:

(1) theoretical analysis coupled with experimental testing of long-term CW-related compound exposed samples;
(2) research and development of instruments or methods that can detect CW-related compounds obtained non-invasively from human matrices;
(3) detection of target compounds where they are absorbed by the body after an attack, or excreted by the body such as hair, nails, skin, etc . (other than urine and feces);
(4) extraction techniques to facilitate on-site and rapid detection of the desired matrix.

Techniques that employ on-site testing or sample extraction techniques are highly desirable. Detection techniques may, but are not required to detect the target compounds themselves. Proposals may also address the detection of changes in human physiology that result from CW exposure.

PHASE I: Demonstrate proof of concept using sample matrices to detect sub-lethal levels of target compounds; document the sampling requirements and testing protocols, results, and conclusions resulting from the study, and provide recommendations for continuing research.

PHASE II: Develop concept demonstrated in Phase I for actual on-site application; develop testing procedure to detect chemical agent; demonstrate prototype’s utility in sensing CW in non-invasively obtained human matrices; refine sampling and analysis methodology; conduct prototype development; provide analytical data.

PHASE III: Reduce the technique developed under Phase II to high volume assays; improve prototype instrument design to reduce cost and provide a system that will be attractive to use in multiple areas of military or homeland defense projects; perform extensive testing of the prototype to develop a marketable product. Commercialization potential includes pharmaceutical industry and environmental protection applications for monitoring exposure to pesticides, herbicides, etc.

REFERENCES:

1. Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on their Destruction, 13 January 1993.

KEYWORD LIST: Sensor, Chemical Weapons, detection, on-site, sampling, analysis, method development, hair, skin, CWC

DTRA02.1-006
Agency: DTRA
Topic#: DTRA02.1-006
Command: DTRA

Title: Particulate Mass Flow

Tech Area:
_ Air Platform _ Chemical/Biological Defense _ Information Systems
_ Ground/Sea Vehicles X Materials/Processes _ Biomedical
X Sensors X Electronics X Battlespace
_ Space Platforms _ Human Systems _ Weapons
_ Nuclear Technology

OBJECTIVE: Develop an instrument that can measure mass flow rates in the products produced by the detonation and or deflagration of an energetic material.

DESCRIPTION: DTRA is currently testing the effects of energetic materials on structures or the contents of structures. Amongst the effects are the loads produced by the fireball that result from the detonation or deflagration. This fireball can contain particulate matter that varies in composition. The object of this effect will be to do the research necessary to produce/innovate a gage or measurement technique that can determine the mass flow rate of this particulate matter in the gases within the fireball. The gage will have to work in thermal environments that can range up to 3000 C. The mass density of the particle can vary widely. It could be, as examples, metal oxides or free carbon. The object is to measure the rate at which particulate mass passes through a given area or the particulate mass flux. The respondent in his proposal should estimate the accuracy and achievable frequency response of the measurement. The frequency response may vary as a function of the particulate size and mass flux.

During Phase I, build a prototype of the gage or system of transducers and demonstrate with laboratory tests and/or small scale field tests that one can infer the particulate mass flux.

During Phase II, build and field a number of the instruments on tests to be specified by DTRA.

PHASE III COMMERCIALIZATION: In addition to the Department Of Defense (DOD) applications, the technology developed will be useful in cloud analysis, smoke stack emissions, and internal combustion engine emissions.

KEYWORD LIST: Stress, Normal Stress, Hard Rock, Conventional Weapons Effects, Nuclear Weapons Effects, Stress Wave Propagation.

DTRA02.1-007
Agency: DTRA
Topic#: DTRA02.1-007
Command: DTRA

Title: The Measurement of Stress in Hard Rock

Tech Area:
_ Air Platform _ Chemical/Biological Defense _ Information Systems
_ Ground/Sea Vehicles X Materials/Processes _ Biomedical
X Sensors X Electronics X Battlespace
_ Space Platforms _ Human Systems _ Weapons
_ Nuclear Technology

OBJECTIVE: Develop an instrument that can reliably measure normal stress in hard rock and help study stress wave propagation in Rock.

DESCRIPTION: DTRA conducts conventional weapons effects tests and simulated nuclear weapons effects tests using high explosives. Often these tests are conducted in hard rock (such as granite) test beds. The measurements done are usually those from which particle velocity can be inferred. It would also be advantageous to measure normal stress. It should be noted that these test beds can be large. The gages may be place in boreholes that can be of the order of 100 meters long. The basic requirement is to obtain data that can be used to infer the normal stress-time history of the stress wave in the rock. The respondent should be able to demonstrate in the laboratory that the proposed technique is a measurement of normal stress. The technique does not necessarily have to be a direct measure of the normal stress time history, it is only required that the normal stress-time history can be inferred from the measurement. Ease of placement of the gage in boreholes will be one of the criteria used to judge the candidate proposals.

During Phase I, build prototypes of the gage and demonstrate with laboratory tests and/or small scale field tests that one can infer both peak stress and stress-time history using the instrument.

During Phase II, build and field a number of the instruments on tests to be specified by DTRA.

PHASE III COMMERCIALIZATION: In addition to the Department Of Defense (DOD) applications, the technology developed will be useful in mine safety applications, shale oil extraction and earthquake prediction and analysis.

KEYWORD LIST: Stress, Normal Stress, Hard Rock, Conventional Weapons Effects, Nuclear Weapons Effects, Stress Wave Propagation.

DTRA02.1-008
Agency: DTRA
Topic#: DTRA02.1-008
Command: DTRA
Title: Fuel Cells for Arms Control Applications

Tech Area:
_ Air Platform _ Chemical/Biological Defense _ Information Systems
_ Ground/Sea Vehicles X Materials/Processes _ Biomedical
X Sensors _ Electronics _ Battlespace
_ Space Platforms _ Human Systems _ Weapons
_ Nuclear Technology

OBJECTIVE: DTRA requires a man-portable fuel cell capable of producing 220 watts of continuous direct current (DC) electrical power for a nominal 12 hours without refueling. The weight of the fuel cell must be such that a person of average strength could carry the unit for a short distance. The fuel cell must be easily refuelable in the field by non technical personnel (e.g., through "clip-in/drop-in" ampoules of fuel) in a way that would not pose a hazardous material risk prior to use, during use in the fuel cell, or following use. The fuel cell, less fuel, must be rugged and transportable as checked baggage on commercial airlines. Furthermore, it must be effective in a wide range of temperatures and other variable environmental conditions.

DESCRIPTION: Technologies capable of verifying future arms control agreements will require self-contained and man-portable power modules for operation in remote locations. Whether the fundamental activity is a part of a portable instrument or an unattended system, long-term power provision in a lightweight, self-contained package is necessary. Power modules may be used to intermittently power computer equipment, video monitoring equipment, or environmental sensors, but the highest power consumption is undoubtedly from thermal cycling applications. Many measurement systems have been demonstrated whose performances are power-limited in remote or rugged applications. Standard power sources are either inordinately heavy/immobile (generators), contribute to operational hazards, or store insufficient energy for the desired applications (e.g., batteries). During on-site inspection activities, the logistics of providing power rapidly becomes the limiting operational factor.

A lightweight high-performance long lasting power module is advantageous because it lowers the support burden, either reducing the number of resupply trips necessary or the amount of equipment needed to transport to an inspection. Currently available fuel cells are bulky, inefficient, and unable to produce the sustained energy required. In both storage and operation, a longer working lifetime is desirable.

The developed fuel cell should employ an innovative approach combining size and power storage capacity with output control modules to maximize the utility and application of the fuel cell. A preference will be given to adaptive learning or control algorithms over hard-wired selective outputs.

PHASE I: Develop a system design based on providing 220 watts of continuous DC electrical power for 12 hours. Demonstrate that the weight of the power module will be such that a person of average strength could carry the unit for a short distance.

PHASE II: Develop and demonstrate a prototype system with a weight, ruggedness, and environmental resistance sufficient to field the fuel cell under harsh conditions. The fuel cell must be easily refuelable in the field by non technical personnel (e.g., through "clip-in/drop-in" ampoules of fuel) in a way that would not pose a hazardous material risk prior to use, during use in the fuel cell, or following use. The fuel cell, less fuel, must be rugged and transportable as checked baggage on commercial airlines. Furthermore, it must be effective in a wide range of temperatures and other variable environmental conditions. Conduct testing to prove feasibility over extended operating conditions.

PHASE III: DUAL USE APPLICATIONS: A portable fuel cell has a wide variety of military and commercial applications in surveillance and security. Examples are remote and perimeter monitoring, securing industrial facilities, and providing power at emergency locations.

KEYWORD LIST: Arms control verification, arms control compliance, fuel cells and batteries, portable power sources, unattended monitoring.

DTRA02.1-009
Agency: DTRA
Topic#: DTRA02.1-009
Command: DTRA
Title: Nuclear Weapon Surety Risk Management

Tech Area:
_ Air Platform _ Chemical/Biological Defense _ Information Systems
_ Ground/Sea Vehicles X Materials/Processes _ Biomedical
_ Sensors _ Electronics _ Battlespace
_ Space Platforms _ Human Systems X Weapons
X Nuclear Technology

OBJECTIVE: Improved Surety of US Nuclear Weapons Systems
DESCRIPTION: Quantifying, reducing, and managing the risks associated with the life-cycle management of military weapon systems, including demilitarization activities, is of vital importance to ensure the safety, security, and control of our nation's nuclear weapons stockpile. To this end, several nuclear weapon system safety assessments and special studies have been or are currently being conducted by the Defense Threat Reduction Agency (DTRA). These use probabilistic risk assessment techniques primarily to quantitatively estimate the likelihood of plutonium release from weapons associated with various delivery platforms resulting from accident-induced abnormal environments. Abnormal environments may include mechanical insults (e.g. drops, vehicle accidents), thermal insults (e.g. fuel fires), electrical insults (e.g. lightning), and combinations of these environments. These risks are estimated to be quite small, but the assessments allow component commanders to better balance the prevention and mitigation of accidents against the potential cost of consequence management and operational requirements by focusing limited resources in those areas which have the greatest potential to continue improving overall stockpile surety. Long-range program thrusts include characterizing these abnormal environments, through test and modeling/simulation, analyzing human factors that can be a significant source of hazards, and developing and integrating quick running codes/models to allow decision makers to manage surety risks. Innovative concepts to improve and extend these techniques and methodologies are desired to continue improving the safety, security and control of the Nation's nuclear weapons stockpile, as well as applying these techniques to other areas of interest to the Department of Defense. DTRA is particularly interested in the following areas of study, which can be evaluated individually of grouped together: 1) analysis and prevention of environments leading to inadvertent nuclear detonation (IND), 2) prediction of consequences from plutonium dispersal and IND in terms of litigation and site restoration, 3) determine a combinatorial optimization of logistics movements to reduce plutonium dispersal risk, and 4) determine the global probability of a terrorist attack on a facility on any given day that can be combined with other probabilities for success or failure given the attack.
PHASE I: Demonstrate the feasibility and potential usefulness of the proposed technology or technique.
PHASE II: Fully develop the proposed technology or technique so they can be compared to existing techniques.
PHASE III DUAL USE APPLICATIONS: Hazard/risk analysis tools and techniques have wide applicability. They are currently used in a variety of high-risk/high-consequence activities, such as space shuttle operations, chemical plant operations, nuclear power operations, ocean engineering, and hazardous waste cleanup. As risk analysis tools and techniques become more prevalent, these techniques may be more quickly and efficiently applied to a greater variety of applications where safety and security risks must be managed. Military organizations may apply these tools through detailed assessments in concert with operational risk management principles; these support operational decisions as well as planning functions. Other federal, state, and local governments may require the use of these tools as the threats of terrorism on

U.S. soil increases and the potential for nuclear-related industries who have lost experienced personnel see the demand increase in the near future.

KEYWORDS: Surety, Safety, Security, Use Control, Risk, Nuclear Weapons, Abnormal Environments, Mechanical Hazard, Thermal Hazard, Electrical Hazard, Human Factors, Risk Reduction, Accident Initiators, Probabilistic Risk Analysis, Risk Mitigation, Risk Management, Consequence Management, Accident Prevention, Optimization, Terrorist.

DTRA02.1-010
Agency: DTRA
Topic#: DTRA02.1-010
Command: DTRA

Title: X-Ray Simulators and Other Pulsed Power Applications

Tech Area:
_ Air Platform _ Chemical/Biological Defense _ Information Systems
_ Ground/Sea Vehicles _ Materials/Processes _ Biomedical
X Sensors X Electronics _ Battlespace
_ Space Platforms _ Human Systems _ Weapons
_ Nuclear Technology

OBJECTIVE: Develop innovative technologies for the efficient production of x-rays for nuclear weapons effects testing and for the application of compact pulsed power to military and civilian systems.

DESCRIPTION: X-ray nuclear weapon effects testing uses radiation sources that generate primarily cold x-rays (1-15 keV), warm x-rays (5-60 keV), or hot x-rays (30 keV). Soft x-rays are used for optical and optical coatings effects testing; warm x-rays are used for thermomechanical and thermostructural response testing; and hot x-rays are used for electronics effects testing. Future requirements for x-ray nuclear weapon effects testing will require substantial improvements in existing radiation source capability, to increase yield and power by 1-3 orders of magnitude, improve spectral fidelity, and increase predictability and experimental control. These improvements may require new concepts in source design, power generation, pulse compression, experimental and measurement techniques, data analysis and modeling, and methods to reduce facility system and operation costs. The proposer should be familiar with the present capability to produce x-rays for nuclear effects testing.

Plasma Radiation Source (PRS) devices are typically gas puffs or wire arrays that are imploded by conduction of large currents to generate soft x-rays. Present PRS designs for high-power DTRA simulators are limited by Rayleigh-Taylor and MHD instability growth, thus innovative load designs may allow for more efficient production of x-rays to meet the goals of increasing fluences by 100-200%. An important contribution could come from physics-based modeling of this complex system, particularly with the high-performance parallel computers now available.

PRS devices generate copious amounts of extraneous debris (material, atomic charged particles, sub-keV photons), from which test objects must be shielded. Debris shields must minimize particle flux and maximize exposure area without significantly reducing x-ray fluence. New, innovative methods, or a combination of methods, may be needed to stop, mitigate, and/or delay debris generated for radiation simulators.

The latest generation of DTRA high-power generators has a relatively large pulse length (~300 ns) which is problematic for both plasma radiation sources and brehmsstrahlung sources. Novel pulse compression technology, including plasma opening switches (POS), flux compression, and even current multiplication could be important for obtaining maximum performance from these x-ray sources. Better computer modeling is needed, especially to understand the opening process in POS and its relationship to conduction dynamics, as well as the dynamics of flux compression.

Bremsstrahlung Radiation Source (BRS) devices generate hot x-rays by impinging an electron beam onto a target converter. Innovative BRS converter and/or beam transport designs are needed to meet future test requirements, by increasing x-ray production (dose) by as much as 3 orders of magnitude, better tailoring pulse width (increased dose rate by as much as 1 order of magnitude), and improving spectral fidelity. These improvements could be effected by innovative new BRS designs, or by better understanding and refinement of existing BRS designs. Comprehensive computer modeling (e.g., PIC codes) of cathode formation and electron emission, beam transport, and/or converter physics, could provide an important contribution.

Diagnostics are critical for understanding how radiation simulators (cold, warm, or hot) are operating and how their performance can be improved. For example, in a PRS machine, these diagnostics are needed during all of the phases of implosion: current build-up, run-in, pinch, and bounce. Innovative diagnostics that can determine with good accuracy the electron density, neutral density, electron temperature, ion temperature, neutral temperature, radiation spectrum, and magnetic field structure, both spatially and temporally resolved, would be a boon to the overall radiation simulator program. In addition, absolutely calibrated x-ray power measurements in different energy spectrums are necessary. Innovative diagnostics are needed to accurately determine the fluence and spectrum of x-rays produced in both cold and hot x-ray simulations.

Future requirements for systems employing pulsed power will necessitate improvements in efficiency, energy density, reliability, repeatability and overall performance over the existing state of the art. Innovative approaches for component or subsystem development are sought to meet future demands for radiation simulators and other pulsed power applications. Examples include more energy efficient pulse forming technologies, high energy density capacitors, more efficient insulators, improved and more reliable switching technologies, and improved power flow electrical circuit models. Pulsed power technologies include those that operate at kilovolts to megavolts and kiloamperes to megamperes, support repetition rates from single pulse to 10 kilohertz, and provide individual pulse risetimes in the nanosecond to millisecond range.

Current DoD pulsed power applications includes x-ray simulators, armor/anti-armor; electromagnetic/electrothermal guns; mine-countermine; electrical vehicle stoppers, and directed energy weapons; etc. Development of new and innovative applications requiring advanced pulsed power technology is also desired, especially applications that may expand a primarily DoD driven requirements base into the commercial sector and reduce component and system costs.

During Phase I, demonstrate the feasibility of the proposed concept.

During Phase II, develop, test and evaluate proof-of-principle hardware. In the event the contractor proposes to demonstrate the prototype in an above ground test simulator, DTRA will coordinate the demonstration at its facility.

PHASE III DUAL USE APPLICATIONS: In addition to the applications cited for developing the environments for simulating the effects of nuclear weapons, the technologies could be useful with the commercial operations of advanced computer modeling of plasmas, nuclear instrumentation, very fast closing valves, material surface treatments, environmental clean-up and high brightness x-ray sources. In addition to the DoD applications cited, these pulse power component technologies will be useful in cleaning up smokestack effluents, general environmental pollution control, metal cutting, and electric vehicles.

REFERENCES:
(1) Inductive Energy Technology for Pulsed Intense X-Ray Sources, K. D. Ware, P. G. Filios, R. L. Gullickson, J. E. Rowley. R. F. Schneider, W. J. Summa, I. M. Vitkovitsky, IEEE Transactions on Plasma Science, Vol. 25, No. 2, April 1997.
(2) Glasstone and Dolan, The Effects of Nuclear Weapons, 1977
(3) DNA EM-1, Capabilities of Nuclear Weapons
(4) Radiation Test Facilities and Capabilities, 1997, DASIAC, 2560 Huntington Ave., Alexandria, VA 22303 (also on web site: http://www.dswa.mil/dswainfo/es/hp.htm)
(5) J. C. Martin on Pulsed Power, Edited by T. H. Martin, A. H. Guenther, and M. Kristiansen, Plenum Press,

New York and London, 1996, ISBN 0-306-45302-9.

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